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## Sexual function and pelvic floor activity in women: the role of traumatic events and PTSD symptoms

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CLINICAL RESEARCH ARTICLE



## Sexual function and pelvic floor activity in women: the role of traumatic events and PTSD symptoms

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### ABSTRACT

**Background:** Traumatic sexual experiences can negatively affect sexual functioning and increase pelvic floor activity in women, especially when post-traumatic stress disorder (PTSD) is developed. However, little is known about the effect of other types of interpersonal and non-interpersonal, traumatic experiences on sexual function and pelvic floor overactivity.

**Objective:** The aim of this study was to examine the effects of lifetime traumatic experiences and subsequent PTSD symptoms on sexual function and pelvic floor activity and to investigate whether the effects differ for interpersonal and non-interpersonal trauma.

**Methods:** Women (N=82) with obesity and a history of infertility, participating in a follow-up study of an RCT investigating a lifestyle intervention programme, completed questionnaires on lifetime exposure to traumatic events (LEC-5), PTSD symptoms (PC-PTSD-5), sexual function (MFSQ) and pelvic floor activity (AOPFS-SV).

**Results:** A large majority of women (85%) reported exposure to at least one traumatic event during their lifetime. Sexual function and pelvic floor activity did not differ between women who experienced non-interpersonal or interpersonal (including sexual) trauma and those who did not experience traumatic events during their lifetime. Women who had developed PTSD symptoms, however, did have higher pelvic floor activity, but sexual function was not affected. Women with a positive screen for PTSD had the highest pelvic floor activity score, and individual PTSD symptoms nightmares and hypervigilance were associated with significantly higher pelvic floor activity scores.

**Conclusion:** Trauma exposure is associated with pelvic floor overactivity in women with a positive screen for PTSD, such that pelvic floor overactivity is more severe with greater PTSD severity. These findings suggest that the development of PTSD after interpersonal trauma is pivotal in this association. Sexual function was unrelated to trauma exposure and pelvic floor function, perhaps related to the fact that the interpersonal trauma events reported in this study were mainly non-sexual.

### Función sexual y actividad del piso pélvico en mujeres: el papel de los eventos traumáticos y síntomas del trastorno de estrés postraumático

**Antecedentes:** Las experiencias sexuales traumáticas pueden comprometer negativamente el funcionamiento sexual e incrementar la actividad del piso pélvico en mujeres, especialmente cuando se desarrolla un trastorno de estrés postraumático (TEPT). Sin embargo, se sabe poco sobre los efectos de otros tipos de experiencias traumáticas, interpersonales y no interpersonales, en la función sexual y la hiperactividad del piso pélvico.

**Objetivo:** El propósito de este estudio fue evaluar los efectos de las experiencias traumáticas a lo largo de la vida, con síntomas del TEPT subsecuentes, en la función sexual y la actividad del piso pélvico e investigar si los efectos difieren entre trauma interpersonal y no interpersonal.

**Métodos:** Un grupo (N=82) de mujeres con obesidad y antecedente de infertilidad que estaba participando de un estudio clínico longitudinal aleatorizado (RCT) sobre un programa de intervención sobre estilos de vida, respondió un cuestionario sobre exposición a eventos traumáticos a lo largo de la vida (LEC-5, por sus siglas en inglés), síntomas del TEPT (PC-

### ARTICLE HISTORY

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### KEYWORDS

Trauma and stressor-related disorders; posttraumatic stress disorder; psychological trauma; interpersonal trauma; sexual trauma; non-interpersonal trauma; sexual dysfunction; pelvic floor overactivity; pelvic floor muscle activity

### PALABRAS CLAVE

trastornos relacionados con trauma y estresores; trastorno de estrés postraumático; trauma psicológico; trauma interpersonal; trauma sexual; trauma no interpersonal; disfunción sexual; hiperactividad del piso pélvico; actividad muscular del piso pélvico

### 关键词

创伤和应激源相关疾病; 创伤后应激障碍; 心理创伤; 人际创伤; 性创伤; 非人际的创伤; 性功能障碍; 骨盆底过度运动; 骨盆底肌肉活动

### HIGHLIGHTS

- Trauma exposure in itself is unrelated to pelvic floor activity and sexual function.
- Only women who experienced interpersonal trauma and developed PTSD symptoms had higher pelvic floor activity, without affecting sexual function.

PTSD-5, por sus siglas en inglés), función sexual (MFSQ, por sus siglas en inglés) y actividad del piso pélvico (AOPFS-SV, por sus siglas en inglés).

**Resultados:** Una gran mayoría de las mujeres (85%) reportó exposición a al menos un evento traumático a lo largo de la vida. No hubo diferencia de la función sexual y la actividad del piso pélvico entre las mujeres que experimentaron trauma no interpersonal, entre las mujeres que experimentaron trauma interpersonal (incluyendo el sexual), y entre aquellas que no experimentaron eventos traumáticos a lo largo de su vida. Sin embargo, en las mujeres que desarrollaron síntomas del TEPT se encontró mayor actividad del piso pélvico, pero sin comprometer la función sexual. Las mujeres con un puntaje significativo para el TEPT presentaban los puntajes más altos en actividad del piso pélvico, y síntomas puntuales del TEPT como pesadillas e hipervigilancia se asociaron a puntajes de actividad del piso pélvico más altos.

**Conclusión:** La exposición a trauma se asocia con hiperactividad del piso pélvico en mujeres con puntajes significativos para el TEPT, y tal hiperactividad del piso pélvico es más severa a mayor severidad del TEPT. Estos hallazgos sugieren que el desarrollo del TEPT luego del trauma interpersonal es un aspecto clave en esta asociación. La función sexual no estaba relacionada con la exposición al trauma o a la función del piso pélvico, quizá relacionado al hecho que los eventos reportados como eventos traumáticos interpersonales eran principalmente no sexuales.

### 女性的性功能和骨盆底活动：创伤事件和PTSD症状的作用

背景:创伤性的性经历会对女性的性功能产生负面影响并增加骨盆底活动,特别是在创伤后应激障碍(PTSD)产生时。然而,关于其他类型的人际和非人际创伤经历对性功能和骨盆底过度活动的影响我们的了解还较少。

目的:本研究的目的是研究终生创伤经历以及随后的创伤后应激障碍症状对性功能和骨盆底活动的影响,并调查人际和非人际创伤的影响是否不同。

方法:有肥胖和不育病史的妇女(N=82),参加一项针对一项生活方式干预计划的RCT随访研究,完成关于一生中遭受创伤事件暴露的问卷(LEC-5),PTSD症状(PC-PTSD-5),性功能(MFSQ)和骨盆底活动(AOPFS-SV)。

结果:绝大多数女性(85%)报告说在其一生中至少经历过一次创伤事件。在经历非人际或人际创伤(包括性创伤)的妇女和一生中未经历创伤事件的妇女之间,性功能和骨盆底活动没有差异。然而,出现PTSD症状的女性确实有较高的骨盆底活动能力,但性功能并未受到影响。PTSD筛查阳性的妇女骨盆底活动评分最高,而个别PTSD症状的恶梦和过度警觉与骨盆底活动评分明显较高有关。

结论:创伤性暴露与PTSD阳性筛查的女性的盆底过度活动有关,因此,PTSD严重程度越高,盆底过度活动越严重。这些发现表明,人际创伤后创伤后应激障碍的发展在这一关联中至关重要。性功能与创伤暴露和骨盆底功能无关,可能是因为本研究中的人际创伤事件主要是非性创伤。

## 1. Background

Worldwide, up to 40% of women suffer from sexual dysfunction (Fugl-Meyer et al., 2004; Laumann, Paik, & Rosen, 1999; Shifren, Monz, Russo, Segreti, & Johannes, 2008). Female sexual dysfunction refers to an impaired 'ability to respond sexually or to experience sexual pleasure' (American Psychiatric Association, 2013) and can take different forms of impairment to the stages of sexual response, such as a decreased sexual arousal, a lack of sexual desire, inability to achieve orgasm, decreased sexual satisfaction, pain during sexual activity, or a combination of these problems (Basson, 2001; Hayes, Bennett, Fairley, & Dennerstein, 2006). Studies have shown that a history of sexual trauma is associated with impaired sexual functioning (Pulverman & Creech, 2019; Pulverman, Kilimnik, & Meston, 2018) and pelvic floor overactivity in women (Cichowski, Dunivan, Komesu, & Rogers, 2013; Hart et al., 2012; Laan & van Lunsen, 2016), especially when PTSD is developed (Yehuda, Lehrner, & Rosenbaum, 2015).

A review of Yehuda and colleagues proposes that the driving effect of PTSD symptoms in the sexual trauma

and sexual dysfunction association may be explained by psychological arousal or hypervigilance, that is being neurally paired with fear in individuals with PTSD (Yehuda et al., 2015). As such, it overrides healthy sexual function and signals of sexual arousal are subsequently perceived as a threat rather than pleasure (Yehuda et al., 2015). Furthermore, cortical adaptation that may at first protect an individual from sensory processing an abusive experience, may later result in for instance sexual dysfunction (Heim, Mayberg, Mletzko, Nemeroff, & Pruessner, 2013). Trauma type may be less important in that regard, suggesting that also after non-sexual trauma, sexual dysfunction may occur. Apart from hypervigilance, additional characteristic symptoms of PTSD may as well be associated with sexual dysfunction, such as avoidance of any sexual activity that may trigger intrusive thoughts or feelings, feelings of detachment during sexual activity, and negative alterations in cognitions and mood that may impair sexual desire or satisfaction (O'Driscoll & Flanagan, 2016).

In recent years, involvement of pelvic floor function in sexual function has gained growing attention (Laan & van Lunsen, 2016; Morin, Carroll, & Bergeron, 2017;

Rosenbaum, 2007). In general, a high tone pelvic floor or pelvic floor overactivity was found to be related to sexual pain problems such as dyspareunia and vulvodynia (Morin et al., 2017, 2017), and with reduced sexual arousal (Both, van Lunsen, Weijenborg, & Laan, 2012). Laan and van Lunsen (2016) have suggested that pelvic floor overactivity gives rise to specific physical symptoms, such as micturition complaints, defaecation problems and sexual complaints. It is proposed that a high tonic pelvic floor can be seen as part of a trauma-related defence mechanism in women with PTSD symptoms (Laan & van Lunsen, 2016).

To date, most studies investigating the relationship between trauma, sexual function and pelvic floor overactivity studied interpersonal trauma, most notably sexual trauma exposure (Hart et al., 2012; Pulverman & Creech, 2019; Pulverman et al., 2018; Yehuda et al., 2015). It is known that interpersonal trauma increases the risk for PTSD (Kessler et al., 2017), but it remains unclear to what extent PTSD symptoms are associated with sexual dysfunction after exposure to non-interpersonal traumatic events. Likewise, the association between pelvic floor overactivity and non-interpersonal traumatic events is also unknown.

The aim of this study was therefore to examine the effects of lifetime traumatic experiences and subsequent PTSD symptoms on sexual function and pelvic floor activity and to investigate whether the effects differ for interpersonal and non-interpersonal trauma.

## 2. Methods

### 2.1. Participants and procedure

The current study is a cross-sectional analysis of the follow-up of a multicentre-randomised controlled trial (RCT). Both the original RCT and follow-up were approved by the institutional medical ethics review committee of the University Medical Centre Groningen (METc code: 2008/284), and the board of directors of each participating hospital (Dutch trial registration number: NTR 1530).

The protocols of the original RCT and the follow-up study have been published elsewhere (Mutsaerts et al., 2010; van de Beek et al., 2018). In brief, 577 women with infertility, aged 18 to 39 years with a Body Mass Index (BMI)  $\geq 29$  kg/m<sup>2</sup> were randomly allocated to a lifestyle intervention followed by infertility treatment or to immediate infertility treatment between June 2009 and June 2012. Women assigned to the intervention group underwent a 6-month preconception lifestyle intervention with a weight reduction of 5–10% as the main goal, or a reduction in BMI below 29 kg/m<sup>2</sup> within the intervention period. We followed women after randomisation in the initial trial during two follow-up phases: on average 5.5 years (range: 3.7–7.0 years) and 6 years (range: 4.2–7.7 years) after randomisation. All

participants gave written informed consent and their data were anonymised. This study was conducted according to the principles of the Declaration of Helsinki.

### 2.2. Measures

#### 2.2.1. Lifetime exposure to traumatic life events

Participants self-reported on lifetime exposure to traumatic life events with the 17-item Life Events Checklist for DSM-5 (LEC-5) (Boeschoten, Bakker, Jongedijk, & Olff, 2014; Weathers et al., 2013). Answer categories of the LEC-5 for each of 17 types of potentially traumatic events are (a) happened to me, (b) witnessed it happening to others, (c) learned about it, (d) in the context of work, and (e) not applicable. Multiple answers for each item were possible.

Based on the LEC-5, the following variables were constructed for the purpose of this study: Experience (no/yes) and variety of potentially traumatic events (theoretical range 0–17); Experience (no/yes) and variety of *interpersonal* events (item 6; physical assault, item 7; assault with weapon, item 8; sexual assault, item 9; other unwanted sexual experience, item 10; combat, item 11; captivity, item 14; witnessed violent death, item 17; other very stressful interpersonal life event), Experience (no/yes) and variety of *non-interpersonal* events (item 1; natural disaster, item 2; fire/explosion, item 3; motor vehicle accident, item 4; other serious accident, item 5; exposure to toxic substance, item 12; life-threatening injury/illness, item 13; severe human suffering, item 15; sudden, unexpected death of a loved one, item 16; caused serious injury/death of another, item 17; other very stressful non-interpersonal life event). Furthermore, the experience and variety of interpersonal trauma were divided into experience and variety of *sexual trauma* (items 8 and 9), and experience and variety of *non-sexual interpersonal* trauma (items 6, 7, 10, 11, 14, 17 interpersonal). Constructed trauma variables were not mutually exclusive. Four women (4.9%) exclusively experienced interpersonal trauma and 30 women (36.6%) exclusively experienced non-interpersonal trauma. A higher LEC-5 total score indicates lifetime exposure to a larger variety of traumatic event types.

#### 2.2.2. PTSD screening

The Primary Care PTSD Screen for DSM-5 (PC-PTSD-5) (Bakker, van der Meer, & Olff, 2014; Prins et al., 2016, 2004) is a screening instrument for PTSD and was obtained if participants indicated they had been exposed to any of the LEC-5 events. The five dichotomous items (*yes/no*) inquire after past-month nightmares, avoidance, hypervigilance, feelings of detachment and guilt. A PC-PTSD-5 total score  $\geq 3$  (out of 5) is a positive screen for PTSD and indicates probable PTSD (Prins et al., 2016, 2004). Total scores



were furthermore transformed into categories 0 symptoms, 1–2 symptoms and 3–5 symptoms as an ordinal scale for PTSD symptoms.

### 2.2.3. Sexual function

Sexual function was assessed using the 19-item Dutch version of the McCoy Female Sexuality Questionnaire (MFSQ)(McCoy, 2000). The MFSQ was designed to measure aspects of female sexuality, has a good test–retest reliability (Pearson  $r = 0.71$ – $0.95$ ) and is able to discriminate between women with and without sexual dysfunction (Giraldi et al., 2011). The following five domains are measured: sexual interest (6 items), satisfaction with frequency of sexual activity (3 items), vaginal lubrication (3 items), orgasm (4 items) and sex partner (3 items on erectile problems of their partner and satisfaction with their partner as a friend and as a lover). One additional item rates intercourse frequency in the past 4 weeks. Only women who had engaged in vaginal intercourse in the past 4 weeks could complete all 19 items, whereas items 1 to 11 could be answered by both women who were sexually active and women who were sexually non-active (McCoy, 2000). The total score was calculated by the sum score of all individual items, with a theoretical range from 19 to 133 points. The total score of both women who had and had not engaged in vaginal intercourse in the past 4 weeks was calculated by the sum score of the individual items 1 to 11, with a theoretical range from 11 to 77 points. A higher MFSQ total score indicates a better sexual function.

### 2.2.4. Pelvic floor overactivity

Pelvic floor overactivity was assessed with the Amsterdam Overactive Pelvic Floor Scale – Short Version (AOPFS-SV). The AOPFS-SV is a 20-item questionnaire scored on 5-point Likert scales ranging from *never* (1) to *very often* (5) measuring the frequency of physical complaints that are indicative of pelvic floor overactivity, such as pain during coitus, voiding problems, painful neck and shoulder stiffness and irritable bowel symptoms (IBS). The questionnaire was developed at the Department of Sexology and Psychosomatic Gynaecology of the Academic Medical Centre, Amsterdam (Postma, Bicanic, van der Vaart, & Laan, 2013). The total score was calculated as the sum score of all subscale scores, with a theoretical range from 4 to 20 points. Higher scores reflect greater pelvic floor (over)activity.

## 2.3. Statistical analysis

Demographical characteristics are shown as means and standard deviations (SD) for normally distributed continuous variables or as medians and interquartile ranges (IQR) for non-normally distributed continuous variables. Frequencies were shown as number of participants (N) and percentage for categorical variables.

Associations between exposure to traumatic events (binary), PTSD symptoms (ordinal) and non-normally distributed continuous MFSQ and AOPFS-SV outcomes were analysed with Mann–Whitney U tests and Kruskal Wallis tests as appropriate. Chi-square tests were used to analyse associations between exposure to traumatic events (binary) and PTSD symptoms (ordinal). A Mann–Whitney U test was performed to exploratively evaluate the association between the five individual PTSD symptoms (nightmares, avoidance, hypervigilance, feelings of detachment and guilt; binary) and sexual function and pelvic floor overactivity scores. Furthermore, a sensitivity analysis was performed including women who reported exclusively experiencing non-interpersonal trauma ( $n = 30$ ) compared to women who did not experience any type of traumatic event ( $n = 12$ ). No sensitivity analysis was performed on women who reported exclusively experiencing interpersonal trauma ( $n = 4$ ), including sexual ( $n = 2$ ) and non-sexual trauma ( $n = 2$ ) compared to women who did not experience any traumatic event due to the low number of women in these different subgroups. Statistical analyses were performed using SPSS version 24 for Windows (IBM Corp., Armonk, NY, USA).

## 3. Results

### 3.1. Participants

Of the 107 women who participated in the follow-up study, 101 women filled out the LEC-5, MFSQ, and AOPFS-SV questionnaires. For 19 women the total MFSQ score could not be calculated because they reported no intercourse in the past 4 weeks ( $n = 10$ ) or the sum score could not be obtained due to missing items ( $n = 9$ ), leading to 82 women with complete outcome data. Table 1 displays the characteristics of the participants.

### 3.2. Lifetime exposure to traumatic events

A large majority of women (85.4%;  $n = 70$ ) reported exposure to at least one traumatic event during their

**Table 1.** Characteristics of participants during follow-up.

Characteristics	Total group ( $n = 82$ )
Age (years, mean, SD)	35.4 (4.3)
Caucasian ( $n$ , %)	80 (97.6)
BMI ( $\text{kg}/\text{m}^2$ , mean, SD)	34.1 (5.2)
Education level ( $n$ , %)	
Primary school	2 (2.4)
Secondary education	17 (20.7)
Intermediate Vocational Education	42 (51.3)
Higher Vocational Education or University	21 (25.6)
MFSQ (score, median, IQR)	96.3 (87.5–103.3)
Intercourse frequency (times per 4 weeks, median, IQR)	4 (2–7)
AOPFS-SV (score, median, IQR)	6.4 (5.3–7.4)

Abbreviations: SD; standard deviation,  $n$ ; number, BMI; body mass index  
AOPFS-SV; Amsterdam Overactive Pelvic Floor Scale – Short Version,  
MFSQ; McCoy Female Sexuality Questionnaire.

lifetime. The median number of experienced traumatic events was three (range: 0 to 15, IQR: 1 to 5), with an average age of exposure at 24.5 years (SD: 7.6) across all trauma types. Interpersonal trauma was reported by 40 women (48.4%). Twenty-two (55.0%) of these 40 women had experienced a sexual trauma, 37 (92.5%) had experienced a non-sexual interpersonal trauma, and 19 (47.5%) had experienced both sexual and non-sexual interpersonal trauma. Non-interpersonal trauma was experienced by 66 women (80.5%). Thirty-six of all women (30%) had experienced both interpersonal and non-interpersonal traumatic events. In total, four women (3%) exclusively experienced interpersonal trauma, of whom two exclusively a sexual trauma and two exclusively a non-sexual interpersonal trauma. Thirty women (24.6%) exclusively reported experiencing a non-interpersonal trauma.

Women who had experienced any type of interpersonal trauma ( $p = 0.01$ ), including sexual interpersonal trauma ( $p = 0.02$ ) and non-sexual interpersonal trauma ( $p = 0.03$ ) had higher PC-PTSD-5 scores compared to women who had not been exposed to these events. PC-PTSD-5 scores for women who had or had not experienced non-interpersonal trauma were comparable ( $p = 0.67$ ).

### 3.3. Trauma exposure, pelvic floor activity and sexual function

Lifetime interpersonal (both sexual and non-sexual) and non-interpersonal trauma were not significantly associated with sexual function nor pelvic floor activity (Table 2).

Sensitivity analyses showed that sexual function and pelvic floor activity did not differ in women who reported exclusive experience with non-interpersonal trauma ( $n = 30$ ) compared to women who did not experience any type of traumatic event ( $n = 12$ ) ((sexual function total score: 100.0 [IQR: 88.5–106.3] vs. 98.0 [IQR: 90.3–106.3], respectively;  $p = 0.88$ ) and (pelvic floor activity score 6.2 [IQR: 5.2–7.5] vs. 6.0 [IQR: 5.1–7.4], respectively;  $p = 0.77$ )). We performed a sensitivity analysis wherein we analysed both women who had and had not engaged in vaginal intercourse in the past 4 weeks ( $n = 92$ ), this did not change the associations between trauma exposure and pelvic floor activity nor sexual function (Supplementary Table SI).

### 3.4. PTSD symptoms and sexual function

Current total PTSD symptoms were not associated with sexual function (Table 3). Furthermore, the PTSD symptom nightmares, avoidance, hypervigilance, feelings of detachment and guilt were not associated with sexual function in our explorative analysis (results not shown).

### 3.5. PTSD symptoms and pelvic floor overactivity

Current PTSD symptoms were significantly associated with pelvic floor activity, with the highest pelvic floor activity score in women with a positive screen for PTSD ( $\geq 3$  symptoms) (Table 3). Post-hoc analysis showed that women with a positive screen for PTSD ( $p = 0.01$ ) had a significantly higher pelvic floor activity score than women with no PTSD symptoms.

An explorative analysis revealed that women who endorsed the items nightmares ( $p = 0.01$ ) and hypervigilance ( $p = 0.04$ ) had a higher pelvic floor overactivity score than women who did not endorse these symptoms (nightmares (yes;  $n = 15$ ): 8.3 [IQR: 6.0–8.8] (no;  $n = 63$ ): 6.3 [IQR: 5.2–7.2], hypervigilance (yes;  $n = 5$ ) 8.8 [IQR: 6.6–15.1] (no;  $n = 73$ ) 6.4 [IQR: 5.3–7.4]. We performed a sensitivity analysis wherein we analysed both women who had and had not engaged in vaginal intercourse in the past 4 weeks ( $n = 80$ ), this did not change the associations between PTSD symptoms and pelvic floor activity nor sexual function (Supplementary Table SII).

## 4. Discussion

This study found that sexual function and pelvic floor activity did not differ between women who have experienced interpersonal (including sexual) or non-interpersonal trauma, and those who did not experience traumatic events during their lifetime. However, women who had developed PTSD symptoms did have higher pelvic floor activity. Sexual function was not affected. Exposure to interpersonal trauma was associated with PTSD symptoms, whereas this association did not exist for non-interpersonal trauma. Women with a positive screen for PTSD (indicative of a probable PTSD diagnosis) had more symptoms indicative of pelvic floor overactivity. Individual PTSD symptom nightmares and hypervigilance were significantly associated with higher pelvic floor activity scores. Our results suggest that interpersonal trauma, that leads to PTSD symptoms, is associated with pelvic floor activity, but not to sexual function.

Trauma exposure in itself was not related to sexual function nor pelvic floor overactivity. This is in line with literature that links the subsequent development of PTSD after sexual trauma exposure to sexual dysfunction and pelvic floor overactivity (Meltzer-Brody et al., 2007; Rosenbaum, 2007; Yehuda et al., 2015). The finding that interpersonal trauma, but not non-interpersonal trauma was associated with PTSD symptoms fits the findings of a large cross-national publication derived from the World Health Organisation (WHO) Mental Health Surveys, where interpersonal traumatic events carried the greatest risk of developing PTSD (Kessler et al., 2017).

PTSD symptoms in our study were not associated with sexual function. This is in contrast with the findings of

**Table 2.** Association between interpersonal and non-interpersonal traumatic life events, pelvic floor activity and sexual function.

Types of traumatic life events <sup>a</sup>	<i>n</i> (%) ( <i>n</i> = 82)	Sexual function total score <sup>c</sup> (median, IQR)	<i>p</i> -value*	Pelvic floor activity total score <sup>b</sup> (median, IQR)	<i>p</i> -value*
<b>Interpersonal trauma</b>			0.08		0.14
No	42 (51.2)	100.0 (90.0–106.3)		6.1 (5.2–7.3)	
Yes	40 (48.8)	93.5 (85.3–101.5)		6.7 (5.8–8.3)	
<b>Sexual interpersonal trauma</b>			0.54		0.22
No	60 (73.2)	98.0 (88.3–103.8)		6.2 (5.2–7.5)	
Yes	22 (26.8)	95.5 (84.8–103.8)		6.8 (5.7–8.3)	
<b>Non-sexual interpersonal trauma</b>			0.20		0.31
No	45 (54.9)	99.0 (89.5–105.0)		6.2 (5.2–7.9)	
Yes	37 (45.1)	94.0 (85.5–102.5)		6.6 (5.7–8.1)	
<b>Non-interpersonal trauma</b>			0.87		0.13
No	16 (19.5)	95.5 (89.3–100.8)		6.0 (5.0–7.0)	
Yes	66 (80.5)	95.3 (85.8–104.3)		6.5 (5.5–8.3)	

<sup>a</sup>Traumatic events were evaluated using the 17-item Life Events Checklist for DSM-5 (LEC-5), a higher LEC-5 total score indicates lifetime exposure to a larger variety of traumatic event types. Different types of traumatic life events are not mutually exclusive <sup>b</sup>AOPFS-SV total sum score, a higher score reflects more symptoms related to pelvic floor overactivity. <sup>c</sup>MFSQ total sum score, a higher score indicates a better sexual function. \**P*-values of continuous outcomes based on Mann-Whitney-U test.

Abbreviations: *n*; number, *IQR*; Inter Quartile Range; *AOPFS-SV*; Amsterdam Overactive Pelvic Floor Scale – Short Version, *MFSQ*; McCoy Female Sexuality Questionnaire.

**Table 3.** Association between PTSD symptoms, pelvic floor activity and sexual function.

	<i>n</i> (%)	Sexual function total score <sup>c</sup> (median, IQR)	<i>p</i> -value*	Pelvic floor activity total score <sup>b</sup> (median, IQR)	<i>p</i> -value*
<b>PTSD symptoms<sup>a</sup></b>	70		0.19		0.02
No symptoms	43 (61.4)	98.0 (88.0–103.0)		6.2 (5.3–7.5)	
1–2 symptoms	19 (27.2)	94.0 (84.5–100.5)		6.3 (5.2–7.0)	
3–5 symptoms	8 (11.4)	101.0 (95.0–110.9)		8.3 (6.8–12.3)	

<sup>a</sup>Primary Care PTSD Screen for DSM-5 (PC-PTSD-5) indicates possible PTSD if PC-PTSD-5 total score  $\geq 3$  (out of 5). <sup>b</sup>AOPFS-SV sum score, a higher score reflects greater pelvic floor overactivity. <sup>c</sup>MFSQ sum score, a higher score indicates a better sexual function. \**P*-values of continuous outcomes based on Kruskal Wallis test.

Abbreviations: *PTSD*; Post-Traumatic Stress Disorder, *n*; number, *IQR*; Inter Quartile Range, *AOPFS-SV*; Amsterdam Overactive Pelvic Floor Scale – Short Version, *MFSQ*; McCoy Female Sexuality Questionnaire.

Postma et al., who found that young women who had been raped, but who no longer had PTSD (after having undergone successful trauma treatment), still had more sexual problems and were more likely to have symptoms indicative of pelvic floor overactivity three years post-treatment than a healthy age-matched control group (Postma et al., 2013). Perhaps, interpersonal trauma that includes sexual assault or rape, in which the pelvic floor is directly involved, is more tightly linked to the likelihood of developing pelvic floor overactivity and sexual problems than non-sexual interpersonal trauma. In the current study, the majority of the interpersonal trauma events were non-sexual.

It seems that particularly women who develop PTSD after interpersonal trauma are more at risk for developing pelvic floor overactivity, because only women who had experienced interpersonal trauma were likely to develop PTSD symptoms, and PTSD severity was associated with pelvic floor overactivity. Several authors have suggested a plausible biological mechanism through which PTSD leads to pelvic floor overactivity. The pelvic floor is linked to the limbic system through the central nervous system, this emotional motor system therefore controls the pelvic floor organs (Blok & Holstege, 1996; Holstege, 2016; Laan & van Lunsen, 2016). In individuals with PTSD, dysregulation is seen in brain regions involved in stress response and emotional processing, which

may give rise to overactivity of the pelvic floor by increasing muscle activity (Liberzon & Phan, 2003; Yehuda et al., 2015). In line with the theoretical model of Yehuda and colleagues, our study provides further evidence that the link between PTSD symptoms and pelvic floor overactivity may particularly be driven by the presence of hypervigilance, which requires high muscle tone (Yehuda et al., 2015). Also in line with the findings of this study, a recent study found that pelvic floor physiotherapy can trigger PTSD symptoms such as nightmares, implying a relation between this specific PTSD symptom and pelvic floor overactivity as well (McKernan et al., 2019). Our findings may be relevant to clinical practice. Since 80% of women experience a traumatic event in their lives (de Vries & Olff, 2009) and 10% develops a diagnosis of PTSD especially after interpersonal trauma, pelvic floor problems form a considerable health risk. Screening for PTSD symptom development may need to be accompanied by screening for pelvic floor overactivity in women with interpersonal trauma.

Some limitations of this study should be noted. This study represents a cross-sectional analysis investigating the relationship between trauma, PTSD symptoms, sexual function and pelvic floor overactivity in a relatively small and specific cohort of women with obesity and a history of infertility, thereby affecting generalisability. It is however unclear whether our



findings are also valid in women without obesity and infertility, as obesity, adverse experiences and PTSD show complex interrelationships (Backholm, Isomaa, & Birgegård, 2013; de Vries, Mocking, & Olff, 2019; Palmisano, Innamorati, & Vanderlinden, 2016; van den Berk-clark et al., 2018). With regard to sexual function, we had limited information about other factors that determine sexual function and could therefore not include these in our analyses. Furthermore, in our study, we did not know whether the lifetime traumatic experiences impacted women's current situation. As PTSD symptoms were assessed considering the past month, they are therefore a reflection of current traumatic burden (McFarlane, 2010; O'Donnell, Elliott, Lau, & Creamer, 2007). Prospective studies investigating the relationship between specific trauma types, PTSD symptoms, sexual dysfunction and pelvic floor overactivity in a longitudinal fashion may provide insight in causality. Furthermore, the PC-PTSD-5 is designed to screen for PTSD and does not provide information on the nature, duration and potential chronicity of PTSD symptoms.

To conclude, lifetime exposure to interpersonal and non-interpersonal trauma was not directly related to pelvic floor overactivity and sexual function. Sexual function was unrelated to PTSD symptoms, perhaps due to the fact that the interpersonal trauma events reported in this study were mainly non-sexual. However, trauma exposure was associated with pelvic floor overactivity in women with PTSD symptoms, such that pelvic floor overactivity is more severe with greater PTSD severity. These findings suggest that the development of PTSD after interpersonal trauma is pivotal in this association between trauma and pelvic floor function. This thus also offers potential for prevention of pelvic floor overactivity, by monitoring and early interventions in case PTSD symptoms develop (Covers et al., 2019; Oosterbaan, Covers, Bicanic, Huntjens, & de Jongh, 2019; Roberts, Kitchiner, Kenardy, Lewis, & Bisson, 2019). Future prospective studies in larger groups of women (with and without obesity and infertility) are needed to address causality. Such studies can also provide a starting point for more trauma-sensitive care in women with pelvic floor overactivity.

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No potential conflict of interest was reported by authors.

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## Competing interests

A. Hoek reports consultancy for Ferring pharmaceuticals BV. The department of Obstetrics and Gynaecology of the UMCG received an unrestricted educational grant from Ferring pharmaceuticals BV, The Netherlands, outside the submitted work. All other authors declare that they have no competing interests.

## Author contributions

AH and HG designed the initial trial. TR, AH, HG, AB, MO, VW and MK designed the follow-up. MK and VW conducted the follow-up. MK analysed the data, drafted and revised the manuscript. VW checked the data analyses. AB, VW, HG, MO, AH, EL and TR interpreted and discussed the results and revised the manuscript. TR had primary responsibility for the final content. All authors revised and approved the final manuscript.

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